GRASSROOTS JOURNALS
ISSN 2564-016X | August 2021

JOURNAL OF ENVIRONMENTAL LAW & POLICY | 01(02) AUGUST 2021
Published by The Grassroots Institute, in partnership with Yaroslav Mudriy National Law University of Ukraine, and in collaboration with Northern Institute of Minority & Environmental Law, University of Lapland. Website: http://grassrootsjournals.org/jelp

OPEN ACCESS Freely available online
M – 00234 | Lead Article

WATER, ENERGY AND FOOD NEXUS INTERVENTIONS: IMPLICATIONS FOR THE ACHIEVEMENT OF THE SUSTAINABLE DEVELOPMENT GOALS IN MALAWI

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Received: 13 July 2021 | **Accepted:** 27 July 2021 | **Published:** 31 August 2021

ABSTRACT

Malawi faces mounting challenges in meeting the growing demand for food, water, and energy to satisfy the needs of a rapidly growing population. Relying on secondary data, the paper argues that while the existing policy initiatives have increased food production to a certain extent, the demand for water and energy has also increased, leading to degradation of the resource base, and contributing to an increase in water-related diseases. Poor sectoral coordination and institutional fragmentation have triggered the unsustainable use of resources and threatened the long-term sustainability of food, water, and energy security in the country, posing challenges to achieving the Sustainable Development Goals (SDGs) in the country. Consequently, this paper substantiates that a nexus approach can enhance understanding of the interconnectedness of the sectors and strengthen coordination among them. However, it requires a major shift in the decision-making process towards taking a holistic view, and development of institutional mechanisms to coordinate the actions of diverse actors and strengthen complementarities and synergies among the three sectors. The framework for cross-sectoral coordination and managing the nexus challenges is also suggested.

Keywords: Climate Change; Malawi; Water; Energy; Food and Sustainable Development

How to cite this paper: Ngozi F Unuigbe and Aizenose Promise Ehizojie, 'Water, Energy and Food Nexus Interventions: Implications for the Achievement of the Sustainable Development Goals in Malawi' (2021) 01(02) Journal of Environmental Law & Policy 1-34. <https://doi.org/10.33002/jelp01.02.01>

Water, Energy and Food Nexus Interventions: Implications for the Achievement of the Sustainable Development Goals in Malawi

1. INTRODUCTION

The Water, Energy and Food (WEF) nexus approach has the potential to help African countries meet Sustainable Development Goals (SDGs).[1] This can only happen if the approach is turned into actions, like policy development and implementation. For the policy to be effective one must take into account what infrastructure is available in a country and a region. This must also be backed up by proper data collection and institutions must be strengthened to overcome bottlenecks. Equally important is the fact that interventions must be designed with the involvement of all stakeholders, including consumers. One common factor is that investment in innovation and technical support is vital so that a range of solutions can be developed.[2] This paper demonstrates that Malawi, like many other African countries, has failed to develop the integrated policy and institutional mechanisms required to address the Water, Energy and Food (WEF) nexus challenge as one interlinked ecosystem.

Although Malawi has made remarkable progress in socio-economic development in recent years, challenges persist in ending hunger and poverty, and ensuring food and nutritional security, an adequate standard of living, access to modern energy, and healthy lives for the vast population. In most developing countries having similar socioeconomic characteristics as Malawi, water, energy and food are inextricably linked in a nexus, as actions in one sector influence the others. Food production requires water and energy; water extraction, treatment, and redistribution require energy; and energy production requires water. Food production and freshwater services depend on water, land, and other natural resources, in other words a range of ecosystem services.

Malawi is a typical agrarian socio-ecological system. The World Bank classifies Malawi as a low-income country with a per capita GDP (in purchasing power parity terms) of US$780 in 2013.[3] Over 53% of the population lives in poverty based on the US$1 per day poverty line.[4] Malawi's population is predominantly rural, with only 15% living in urban areas.[5] In 2013 more than 77% of households depended on agriculture for

1 Eloise M. Biggs and others, 'Sustainable Development and The Water–Energy–Food Nexus: A Perspective on Livelihoods' (2015) 54 Environmental Science and Policy <http://dx.doi.org/10.1016/j.envsci.2015.08.002> accessed 6 August 2021.

2 Agathe Maupin and Mercy M. Ojoyi, 'Africa needs to manage food, water and energy in a way that connects all three' (University of the Witwatersrand University of Johannesburg, January 2017) < https://www.wits.ac.za/news/latest-news/in-their-own-words/2017/2017-01/> accessed 4 August 2021.

3 World Bank. Country and Lending Groups. (2015) <http://data.worldbank.org/about/country-andlending-groups> accessed 15 December 2020.

4 C. I. A. 'The World Fact Book: Malawi' (2015) <https://www.cia.gov/library/publications/theworld-factbook/geos/mi.html> accessed 15 December 2020.

5 National Statistical Office, *Integrated Household Survey 2010-2011 – Household Socio-Economic Characteristics Report.* (Malawi National Statistical Office 2012)

their livelihood.[6] Farming takes place on fragmented small parcels of customary land.[7] The agricultural sector is the main source of economic growth and exports, representing about 37% of gross domestic product and 82.5% of foreign exchange earnings.[8] Furthermore, due to low agricultural productivity levels, Malawi remained classified as a low-income food-deficit country by the FAO in 2014.[9]

Malawi is heavily reliant on biomass energy, with 90% of the population using wood or charcoal as a primary source of energy.[10] Only 8% of the population is connected to the electricity grid, with huge disparities between urban (25%) and rural areas (1%).[11] Water infrastructure is generally poorly developed, especially in the rural areas, and modern irrigation systems are underdeveloped. Most agriculture is rain-fed. The overreliance on singular sources of food (maize) and energy (biomass) both make the country more vulnerable to climate change (droughts and flooding), while aggravating its effects, as the pressure on woodlands has led to deforestation in several parts of the country.[12]

With growing populations, declining agricultural land, increasing stress on water and energy resources, and climate variability and change, Malawi faces the challenge of how to produce more food with the same or less land, less water, and increased energy prices, while conserving resources and maintaining environmental sustainability. The sustainability of maize production is under threat because of its heavy reliance on water and energy, growing water stress and energy shortages, poor functioning of irrigation systems, and increased competition for water and energy. The Sustainable Development Goals (SDGs) by the global community are critically important for Malawi with respect to ensuring water, energy and food security in a way that does not undermine sustainability for future generations.[13]

<https://www.resakss.org/sites/default/files/Malawi%20NSO%202012%20Integrated%20Household%20Survey%202010%20-%202011%20-%20Household.pdf> accessed 11 April 2021.

6 AQUASTAT, Water report for Malawi (2015) <http://www.fao.org/countryprofiles/index/> accessed 15 December 2020.

7 G. E. T. Gamula, Liu Hui and Wuyuan Peng, 'An Overview of the Energy Sector in Malawi' (2013) 5 Energy and Power Engineering 8.

8 African Development Bank, 'Malawi Country Strategy paper (2014-2018)' (2013) <http://www.afdb.org/en/countries/southern-africa/malawi/malawi-economicoutlook/> accessed 15 December 2020.

9 Thea Nielsen and others, 'The Food-Energy-Water Security Nexus: Definitions, Policies, and Methods in an Application to Malawi and Mozambique' (IFPRI Discussion Paper 01480 November 2015) <http://ebrary.ifpri.org/utils/getfile/collection/p15738coll2/id/129808/filename/130019.pdf> accessed August 42021.

10 Gamula, Hui,Peng (n 7)

11 Renewable Energy and Energy Efficiency Partnership [REEEP]. *Policy DB Details: Malawi.* 2012. <http://www.reeep.org/index.php?id=9353&special=viewitem&cid=94> accessed 15 December 2020.

12 Patsani G Kumambala andAlan Ervine, 'Site selection for combine hydro, irrigation and water supply in Malawi: Assessment of water resource availability' (2009) 248 Desalination 537

13 Blake Robinson and Jeremy Wakeford, 'Oil Shock Vulnerabilities & Impacts: Case Study of Malawi' (Paper prepared for United Kingdom Department for International Development June 2013).

To feed its growing population, Malawi has pursued policies aimed at achieving national food self-sufficiency through production of staple crops. However, their objective relies on more intensive use of water, energy, and chemical inputs. These policies have contributed to increased food production,[14] although not necessarily a more nutritious diet, but at the cost of accelerated degradation of critical natural resources such as land, soil, and water, and serious environmental impacts including groundwater depletion, waterlogging, salinity of soil, water pollution, and biodiversity loss. Another example is the policy of subsidies which leads to overuse of water and energy and can even be counterproductive.[15] Though it is true that energy subsidies can promote social objectives (when judiciously used), especially in case of the absence of social welfare mechanism for supporting the poor. However, subsidies end up lowering end-user prices. This will result in increased energy use and reduce incentives for sustainable energy use leading to inefficient consumption path which is unsustainable.[16]

Negative environmental impacts can arise from intensive agriculture, e.g., waterlogging and salinization of soils and increased incidence of waterborne and water-related diseases. Because of the intensive energy use, food production has become increasingly vulnerable to changes in the energy availability and costs. The challenges of ensuring food, water, and energy security are further compounded by the potential impacts of climate change on water resources and on energy use, and by increasing competition for land and water for bioenergy and hydropower. Food choices and agricultural practices influence water and energy demand. Similarly, water, energy, and land demand are influenced by different policies, for example those relating to agriculture, energy, land-use, food, fiscal, credit, prices, and subsidies.[17] These relationships are dynamic.

However, policies in Malawi, as in many developing countries, are generally narrowly sectoral, with a disconnect between those for food, water, and energy. By ignoring the underlying interdependence of the three sectors, policies sometimes have the unintended consequence of shifting a crisis from one sector to another. Additionally, policies and actions which are taken in

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[14] Thea Nielsen and others (n 9)

[15] Golam Rasul, 'Managing the food, water, and energy nexus for achieving the Sustainable Development Goals in South Asia' (2016) Vol. 18 Environmental Development 14–25 <http://dx.doi.org/10.1016/j.envdev.2015.12.001> accessed 4 August 2021.

[16] Analysis of the Scope of Energy Subsidies and Suggestions for the G-20 Initiative: IEA, OPEC, OECD, World Bank Joint Report (prepared for submission to the G-20 Summit Meeting Toronto (Canada), 26-27 June 2010) <https://www.oecd.org/env/45575666.pdf> accessed 4 August 2021.

[17] Golam Rasul and Bikash Sharma 'The nexus approach to water–energy–food security: an option for adaptation to climate change' (2015) *Climate Policy*, <http://dx.doi.org/10.1080/14693062.2015.1029865> accessed 4 August2021; Golam Rasul, 'Food, water, and energy security in South Asia: A nexus perspective from the Hindu Kush Himalayan region' (2014) Vol. 39 *Environmental Science & Policy* 35-48 <http://dx.doi.org/10.1016/j.envsci.2014.01.010> accessed 4 August, 2021; Golam Rasul, 'Managing the food, water, and energy nexus for achieving the Sustainable Development Goals in South Asia' (2016) Vol. 18 *Environmental Development* 14–25 < http://dx.doi.org/10.1016/j.envdev.2015.12.001> accessed 4 August 2021.

isolation, without considering their impact on other sectors, can aggravate resource constraints.

With competing demand for resources and increasing environmental pressure, an important challenge facing Malawi is how to minimize conflicts among the three main sectors of food, water, and energy, and promote synergies in policies and instruments. At present, policies and instruments are developed without adequate consideration for the cross-sectoral consequences. The lack of connection between sectoral agencies has created an imbalance between the sectors in terms of demand and supply. Conducted cross-sectoral efforts have remained linear, such as taking into account water for food or energy for food. While the agricultural policy framework has contributed to an increase in food grain production, it imposes a huge pressure on water and energy resources, which in turn has weakened the sustainability of the agriculture.

The connections between macro-economic and sectoral policies and cross-sectoral impacts are not internalized into national policies. The cross-sectoral externalities have placed additional pressure on land, water, energy, and other scarce resources and undermined the long-term sustainability of water, energy and food security. The major challenge therefore facing Malawi (as other developing countries) is how to decouple food production from water and energy use intensity and environmental degradation to make it sustainable. The planned Sustainable Development Goals (SDGs) of zero poverty (SDG1), ending hunger and food insecurity (SDG 2), ensuring water security (SDG 6), access to modern energy (SDG 7), sustainable economic growth (SDG 8), sustainable consumption and production (SDG12), and conservation, protection, and sustainable use of marine and terrestrial resources and ecosystems (SDGs 14 and 15) are closely interlinked and success in achieving them will depend heavily on ensuring the sustainable use and management of water, energy, land (food), and other natural resources.[18] These factors are not only interdependent, they also both reinforce and impose constraints on one another.

The goals are interlinked in different ways. Achieving the goal of food security and ending hunger, for example, depends strongly on achieving the goal of water and energy security which is needed to ensure water and energy is available for food production. Similarly, the ability to achieve the goal of water and energy security will largely depend on the ways in which food is produced, processed, transported, and consumed. Enhancing the efficiency of water, energy, and land use can ease the trade-offs and resource conflicts. Ensuring resource use efficiency, however, will not be sufficient to sustain water, energy and food security in the long run unless natural resources and ecosystems are conserved and used sustainably. The natural resource base and health of the ecosystem set the conditions for sustainable

[18] Nina Weitz, Manns Nilsson and Marion Davis, 'A Nexus Approach to the Post-2015 Agenda: Formulating Integrated Water, Energy and Food SDGs' (2014) Vol. 34 (2) SAIS Review of International Affairs 37-50.

production. Finally, ensuring healthy lives cannot be achieved by achieving a particular goal; it depends on multiple goals ranging from ensuring food, water, and energy to inclusive growth, healthy ecosystems, and protection of the environment. Like the food, water, and energy nexus, the SDGs are closely interlinked. Thus water, energy and food security, and the SDGs need to be addressed in an integrated way in Malawi.

Despite the inherent interconnectedness of water, energy and food, little effort has been made in Malawi to recognize the interdependencies of resource use, policies, and institutional or regulatory arrangements. Thus the present research will specifically: (1) demonstrate how the SDGs 2, 6, and 7 with their respective targets are interconnected; (2) present a preliminary pilot platform to assess the impact of the water targets on the food and energy targets in Malawi; (3) explore possible trade-offs for implementing different levels of the proposed water, energy, and food national plans; (4) propose interventions within the three national plans (social, policy, technical), at different scales, which have the potential of reducing the existing competition and ensure a more sustainable resource allocation; (5) demonstrate how such interventions must be hinged on effective stakeholder mapping and capacity development in order to be effective.

2. CASE STUDY

Malawi has a primarily rural population, with only 16 percent of the population residing in urban areas. It also has a relatively youthful population; 44 percent of the population is under 15 years.[19] Malawi has benefited from decades of peace and political stability but is susceptible to climate shocks. The 2015–2016 growing season was negatively affected by El Niño, which caused late rains and prolonged dry spells.[20]

Malawi's economy is highly dependent on agriculture with 80 percent of the population being smallholder famers. Agriculture contributes about 30% to the GDP and accounts for 90% of total foreign exchange earnings Malawi's GDP growth rate is expected to improve if weather patterns continue to improve and remain favourable for agricultural production.[21] However, despite projected economic improvement, 66 percent of the

[19] Population Reference Bureau, '2017 World Population Data Sheet' (2017) <http://www.prb.org/pdf17/2017_World_Population.pdf> accessed 4 August 2021.

[20] Malawi Vulnerability Assessment Committee (MVAC), 'National Food and Nutrition Security Forecast, April 2016 to March 2017' (2016) <http://vam.wfp.org/CountryPage_assessments.aspx?iso3=mwi> accessed 15 December 2020.

[21] USAID, 'Food Assistance Fact Sheet – Malawi' (2017) <https://www.usaid.gov/malawi/food-assistance> accessed 15 December 2020; World Bank, 'Malawi Country Overview' (2017) <http://www.worldbank.org/en/country/malawi/overview> accessed 15 December 2020; Government of Malawi, *Malawi 2015 Floods Post Disaster Needs Assessment Report* (World Bank Group 2015) <https://reliefweb.int/report/malawi/malawi-2015-floods-post-disaster-needs-assessment-report> accessed 15 December 2020.

population continues to live on less than US$1.90 a day.[22] Currently, Malawi ranks 143 out of 157 countries in progress toward meeting the Sustainable Development Goals (SDGs).[23] According to the most recent DHS (2015–2016), 16 percent of female deaths are related to pregnancy or childbearing, and 1 in 16 children will die before the age of 5, with two-thirds of these deaths occurring during infancy.[24]

About 85% of Malawi's human population lives in rural areas where agriculture is the main source of livelihood.[25] Agriculture's contribution to foreign exchange and GDP has been driven primarily by tobacco, the country´s main cash crop and foreign exchange earner. Tea and sugar are the other important export crops. Domestically, maize is the predominant food crop, grown by nearly all smallholders throughout the country, and contributes to more than half of the national calorie uptake. Given the importance of the crop in the Malawian diet, maize production is vital to the general welfare of the population and is therefore an important social and political variable.[26]

Malawi is generally rich in both surface and ground water resources. Surface water resources comprise a network of rivers comprising North and South Rukuru and Songwe in the Northern Region, Linthipe, Bua, Dwangwa in the Central Region, and Shire and Ruo in the Southern Region. Groundwater resources are mainly found in two key aquifer systems: the extensive but low yielding Pre-Cambrian Basement Complex aquifer, and the high yielding alluvial aquifer along the shores of Lake Malawi and Lake Chilwa, and in the Upper and Lower Shire Valley. But despite the availability of abundant water resources in the country, only 2.3% of total arable land is irrigated, and the largest proportion (52%) is estate or plantation farms, mostly growing sugarcane and tea.[27] Smallholder irrigation, which comprises 48% of irrigated land, remains virtually under-developed. Shire River is the outlet of Lake Malawi and accounts for about 98% of the country's hydropower generating capacity, which makes the country's industrial development almost entirely dependent on the Shire River for its energy.[28] In this regard, reduced flows into Lake Malawi by the tributary rivers have a direct effect on flows in the Shire River, and a consequent bearing on reduced energy generation capacity. In recent years,

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22 Jeffrey Sachs and others, *SDG Index and Dashboards Report 2017* (Bertelsmann Stiftung and Sustainable Development Solutions Network 2017).

23 ibid 63.

24 National Statistical Office (NSO) [Malawi] and ICF, *Malawi Demographic and Health Survey 2015–16*. (2017) Zomba, Malawi, and Rockville, Maryland, USA: NSO and ICF.

25 ibid.

26 FEWS NET, 'Malawi Food Security Outlook Update' (2017) <https://reliefweb.int/sites/reliefweb.int/files/resources/MW_FSOU_2017_12_final.pdf> accessed 15 December 2020.

27 Global Water Partnership, 'National Consultations on Water, Food Security and Nutrition' (A Final report of National Consultation on Water, Food Security and Nutrition in Malawi, May 2016) < https://www.gwp.org/globalassets/global/activities/news/july-2016/gwp---malawi-country-report.pdf> accessed 15 December 2020.

28 ibid.

intermittent hydropower generation has been attributed mainly to droughts and floods episodes. Water flow disruptions in the Shire and its tributaries have been exacerbated by siltation caused by poor and unsustainable land husbandry practices and deforestation taking place in the catchment area, and the infestation of waterweeds, such as water hyacinth.[29]

Fish is the main source of animal protein in Malawi. About 70% of total human population derive their animal protein uptake from fish, most of which are harvested from Lake Malawi. A large percentage of the population of people living along the shores of Lake Malawi, Lake Chilwa and Lake Malombe depend on fish resources for the sustenance of their livelihoods.[30] For the past decade or so, droughts and floods have been the major climatic hazards affecting fisheries production and have contributed immensely towards the declining or even drying up of water bodies, resulting in low fish catches and loss of biodiversity. Floods have been responsible for the destruction of fish ponds, whilst droughts have led to low water levels in the main water bodies and reservoirs, or even the drying up of rivers and lakes. For example, the drying up of Lake Chilwa in 1995 resulted in total loss of fish stocks.[31]

The totality of the calamities highlighted above has led to extreme food shortages in Malawi, and it is against this background that the Government is committed to redress the resultant effects for the country to meet both its food security and nutrition as well as water needs for its rapidly growing population.

3. KEY CHALLENGES FOR MALAWI

3.1 Poor Catchment Conservation

At the moment, sedimentation is a serious problem that rivers and lakes in Malawi are experiencing. With increased catchment degradation, large volumes of sediments washed down from catchments get deposited in rivers and lakes, thereby clogging water treatment works for domestic water supply, irrigation canals, and hydropower generation infrastructure.[32] Malawi has more than 56 gravity fed water supply schemes and more than 750 small earth dams, four large dams; namely, Lunyangwa Dam in Mzuzu, Kamuzu Dams I and II in Lilongwe, and Mulunguzi Dam in Zomba. But due to excessive siltation, some of these gravities fed schemes and small earth dams have stopped functioning. Of late, water supply to Lilongwe City has tremendously declined due to the siltation of Kamuzu Dams I and II caused by destruction of Dzalanyama Forest Reserve, the main source of the rivers that feed into the two dams. The challenge of poor catchment conservation

[29] ibid/
[30] ibid.
[31] ibid.
[32] ibid.

has widely been acknowledged as causing food insecurity and water resource degradation and depletion.[33]

3.2 Food Insecurity

Food insecurity in Malawi (which is mainly an agrarian society), has been significant and some of the drivers of hunger are weather associated factors like flooding, drought and erosion.[34] For instance, in 2012/13 about 1,630,000 people relied on food relief while in 2013/14 about 1,154,000 people relied on food hand-outs.[35] In 2015/16 the figure rose to about 2.86 million people. In 2018, 3.3 million Malawians were food insecure, 1.8 million in 2019, and 2.6 million were anticipated in 2020.[36] According to the Second Round Agricultural Production Estimates Survey (APES) released by the Ministry of Agriculture, Irrigation and Water Development in March, the country's main staple food, maize registered a decline of 12.4 percent as compared to the 2014/15 final round estimate.[37]

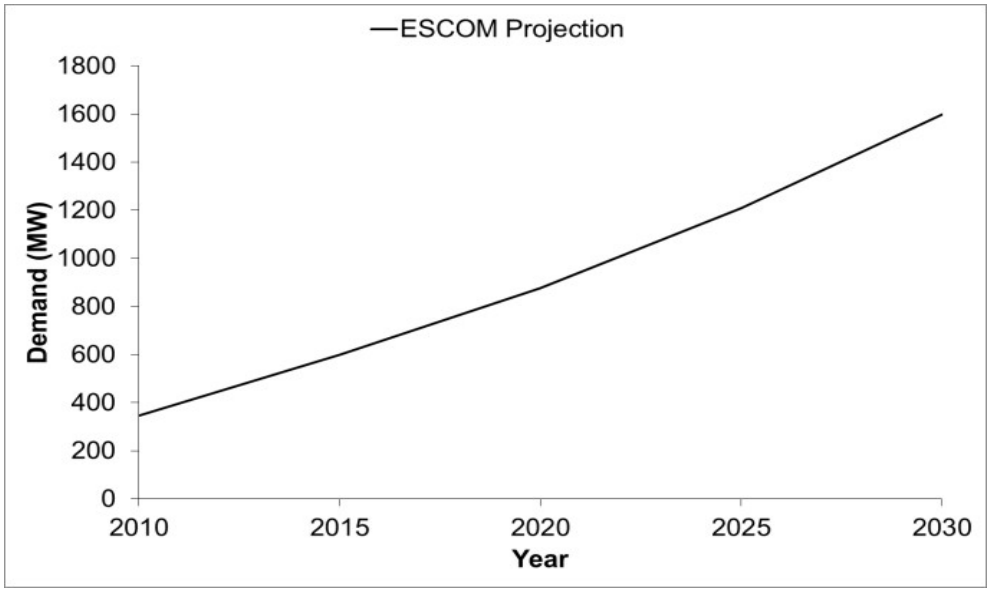

Figure 1: ESCOM Food Demand Projections for Malawi from 2010-2013

[33] ibid.

[34] Tilele Stevens and Kaveh Madani, 'Future climate impacts on maize farming and food security in Malawi' (2016) 6:36241 Scientific Reports, DOI: 10.1038/srep36241; Madhumita Paul, 'Some 2.64 Million Malawians Face Acute Food Insecurity Between January And March: Report' (12 January 2021) https://www.downtoearth.org.in/news/africa/some-2-64-million-malawians-face-acute-food-insecurity-between-january-and-march-report-75030 accessed 4 August, 2021; Global Water Partnership (n 27).

[35] Global Water Partnership (n 27).

[36] Blessings Botha, 'Amid maize bumper harvests in Malawi, food insecurity reigns' (October 2020) <https://blogs.worldbank.org/africacan/amid-maize-bumper-harvests-malawi-food-insecurity-reigns> accessed 4 August2021.

[37] FEWS (n 20).

3.3 Poor Irrigation Development

There is a growing national demand for water resources particularly during the dry season. This has resulted in calls for better Water Resources Management (WRM) and its development to ensure that water resources do not limit social and economic development and poverty reduction in the country. Over the years Malawi has been facing problems of water scarcity due to climate change, environmental degradation, and lack of storage and reservoirs.

The country is divided into 17 Water Resources Areas (WRAs), which are subdivided into 78 Water Resources Units (WRUs). There are two major drainage systems: The Lake Malawi system, which is part of the Zambezi River basin. The Shire River is the only outlet of the lake with an average flow of 400 m/s of water.[38] The government placed a high priority on irrigation and WRM development in order to ensure food and water security at household level, for example, through water harvesting, improved water catchment and management. The department of WRM in MoAIWD has constructed over 25 small to medium multipurpose dams in the 24 districts across the country to make water resources readily available for multiple uses.[39]

By 2010 the demand for water in Malawi was already greater than the supply in many WRAs with the situation predicted to worsen in the future.[40] In addition, data for 17 WRAs shows a deficit of 110 Ml/d in 2010 increasing to 170 Ml/d by the year 2020 and worsening to 956 by the year 2035.[41]

Notwithstanding the drought related decline in crop production, irrigation in Malawi is under-developed. According to the Irrigation Master Plan and Investment Framework (2015), Malawi has an irrigation potential of about 408,000 hectares. At present, however, only 104,463 hectares have been developed, representing 26% of potential irrigable land. Out of this, about 52,144 ha (49.8%) are under smallholder farmers while 52, 499 (50.2%) ha are under commercial estates.[42] The area under irrigation is low partly due to low levels of financing, high cost of irrigation investment, low levels of economic rate of return and unfavourable financing mechanisms prevailing in the country. On average, it costs about US$10,000 to develop one ha for irrigation. It also takes about 3 to 5 years for an investor to start realizing profits (economic rate of return) from irrigation investment.

3.4 Energy Insecurity

Given its relatively small landmass, large (and growing) population and heavy dependence on fuel wood, Malawi is an increasingly energy-stressed country. The National Energy Policy estimates that 93% of total energy demand is met by biomass energy. Households consume 84% of the total primary energy. A staggering 99% of household energy is supplied by

[38] FAO (n 25).
[39] MoAIWD (n 22).
[40] ibid.
[41] ibid.
[42] (AGWA, 2015).

biomass. This, with increasing population growth, is exerting significant pressure on the country's forest resources, leading to forest degradation and deforestation at a rate of 2.6% per year. 87% of the population uses firewood and 8% charcoal to satisfy their thermal energy needs. Less than 7% of the 14 million people are connected to the national grid.[43] The connected demand far exceeds the supply of 320 MW installed generation capacity. Thus, load shedding is frequent. Less than 2.3% of the total national energy demand is met by electricity, 3.5% by liquid fuels and gas, and 1% by coal.[44]

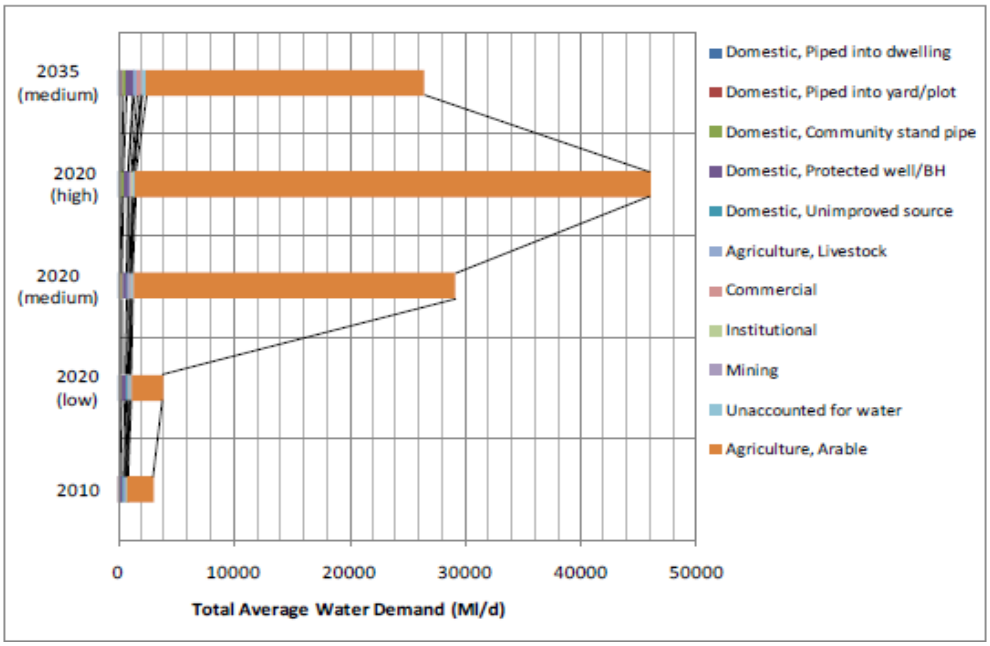

Figure 2: Projected increases in total average water demand (Ml/day) from 2010 baseline.[45]

Electricity and gas are only intermittently available and considered to be too expensive for cooking; for example, electricity tariffs were raised by 84% in 2013. Therefore, firewood and charcoal are the major cooking fuels, even in the urban areas.[46] Most of the charcoal is consumed in urban areas – representing 46% of total demand. Unlike in many neighbouring countries, firewood is still available in all four major cities of Malawi (Lilongwe, Blantyre, Zomba and

[43] Joseph Kalowekamo, 'Biomass energy strategy' (March 2013) <http://mbaula.org/index_htm_files/2%20-%20BEST%20Presentation.pdf> accessed 4 August 2021; Malawi Energy Situation, Energypedia <https://energypedia.info/wiki/Malawi_Energy_Situation > accessed 4 August 2021.

[44] Government of Malawi, *Malawi 2015 Floods Post Disaster Needs Assessment Report* (World Bank Group 2015) <https://reliefweb.int/report/malawi/malawi-2015-floods-post-disaster-needs-assessment-report> accessed 15 December 2020.

[45] Anthony Hurford, Steven Wade and J Winpenny, 'Malawi Case Study: Harnessing Hydropower' (A report submitted to Department for International Development (DFID), United Kingdom 2014).

[46] ESCOM, 2013.

Mzuzu) as well as in the district capitals. Firewood provides over 50% of the urban cooking fuel and nearly 100% in the rural areas.[47]

Even in urban areas, firewood is mainly used in open three-stone fires. Therefore, there is a potential to introduce convenient affordable portable firewood stoves in urban areas and shift eventually some parts of the cooking activities currently done with charcoal to a less primary-energy intensive fuel source, meaning un-carbonised firewood. Charcoal in Malawi is mostly unsustainably produced from live trees: over 60% of the charcoal is made from wood originating from protected Forest Reserves and National Parks; even firewood is unsustainably collected.[48]

The Maplecroft's Climate Change and Environment Risk Atlas shows that Malawi is increasingly vulnerable to the impacts of climate change. According to the new Climate Change Vulnerability Index (CCVI), there are 30 countries at 'extreme risk' worldwide. Malawi moved fast from position 15 in 2011 up to number 9 on this list.[49] This explains why the Ministry of Environment and Climate Change Management is supporting the initiative to promote energy efficient biomass appliances like cookstoves to reduce the quantity of solid biomass required for preparing a meal.[50]

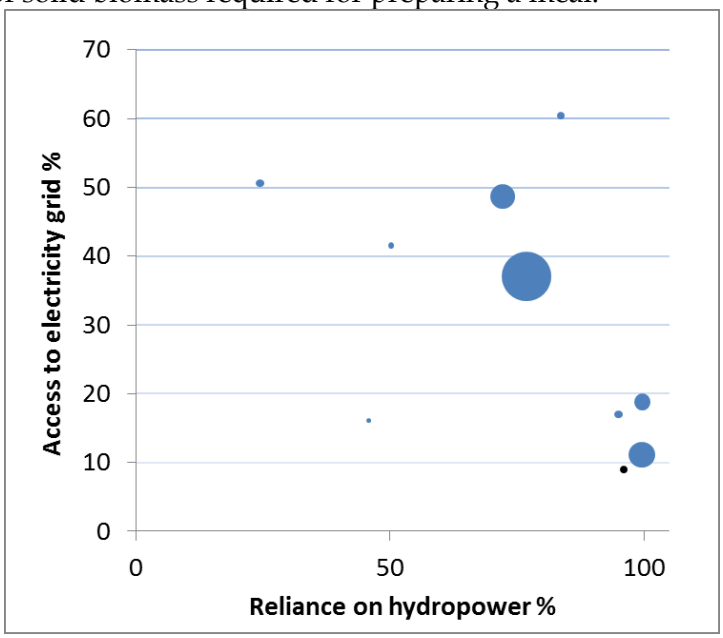

Figure 3: Reliance on hydropower and access to electricity with water availability per head represented by the size of the circles. The black circle represents Malawi.[51]

[47] A Bogdanski and C Roth, 'Integrated food-energy systems: Growing fuel wood on farm in Malawi' (2012) 26(2) Nature & Faune 57

[48] J Taulo et al., 'Energy Supply in Malawi: Options and Issues' (2015) 26(2) Journal of Energy in Southern Africa, 19.

[49] Bodanski and Roth (n 47).

[50] Charles Jumbe and Arild Angelsen, 'Modelling Choice of Fuelwood Source Among Rural Households In Malawi: A Multinomial Probit Analysis' (2011) 33(5) Energy Economics 732.

[51] World Bank, World Development Indicators (Washington, DC: 2013).

4. CURRENT CROSS SECTORAL POLICIES ON WATER, ENERGY AND FOOD IN MALAWI

This section assesses the trends and issues in food, water, and energy security in Malawi and their interconnected challenges. It begins by examining food security policies, followed by the sections showing how policy interventions in one sector have engendered knock-on negative externalities in others, and increased pressures on their sustainability.

4.1 Food Security Policies

In the attempt to harmonize policies, the government reviewed the various national development strategies and agricultural related legislation and policies and produced the Agricultural Policy Framework (APF). The APF summarizes the objectives of agricultural development, strategies and policies that will be pursued to achieve both stated and commonly perceived agricultural objectives.[52] The purpose of the APF was to increase agricultural productivity so as to ensure food security and sustainable agricultural growth and development.

The Malawi Agricultural Policy framework and the MGDs are consistent with the Comprehensive Africa Agriculture Development Programme (CAAPD) in terms of objectives of agricultural development and the key areas of focus in order to achieve sustainable development.[53] The Agricultural Sector Wide Approach process (ASWAp) is a path that Malawi has chosen to align its agricultural development agenda with the CAADP process. The ASWAp has five broad focus areas called priority pillars; namely, (i) Food security and risk reduction, (ii) Agribusiness and Market Development, (iii) Sustainable Land and Water Management, (iv) Research, Technology and Dissemination and (v) Institutional strengthening and capacity building.[54]

The ASWAp is an investment framework that will guide government and development partners in the implementation of result-oriented priority programmes in the agricultural sector. The ASWAp is also a programme approach to development that will broaden ownership by government over decision making on policy, strategy and spending, increase coherence between sectoral policies, reduce transaction costs through the use of government procedures and strengthen national institutions.[55]

Malawi needs substantial increases in its agricultural growth rate if it is to significantly reduce poverty and lay the foundation for any kind of structural transformation that will benefit a large portion of the population. The CAADP, which is a concept of the New Partnership for African Development (NEPAD), has set out the agricultural GDP growth rate target

[52] (MoAIWD) 2006.
[53] (MoAIWD, 2009).
[54] ibid.
[55] ibid.

of 6% per annum for African countries tasked to find ways to achieve this target. The ASWAp is therefore using a minimum target of 6% growth in the agricultural sector as recommended by the CAADP.

The GoM adopted a National Irrigation Policy and Development Strategy (NIPDS) in June 2000. The NIPDS, supported by an Irrigation Act passed in 2001, states that GoM will assume the role of facilitator of sustainable irrigation development in areas having potential, using a participatory approach, and will embark on developments only if the smallholder farmers in the area request such development and meet the criteria for sustainable development. The NIPDS aims to: (i) identify areas with irrigation potential; (ii) encourage private sector development of irrigated agriculture (estates and commercial farms); (iii) assist smallholders to develop and manage their own self-help irrigation schemes; (iv) transfer management of existing government schemes to their beneficiaries; (v) assist informal sector irrigation; (vi) enhance national capacities for irrigation development; (vii) conduct research in irrigation technology; and (viii) promote the use of both simple and advanced irrigation.[56]

Malawi's Farm Input Subsidy Program (FISP) has shaped the country's development and agricultural policy the most. This national program began in 2005 after the end of several maize input subsidy programs from the 1990s and severe droughts early in the following decade.[57] Since its inception, its expenditures have accounted for more than 60 percent of Malawi's agricultural budget. FISP aims to enhance food security through improving agricultural productivity by increasing maize production, promoting household food security, and increasing income[58] by decreasing the costs of fertilizer and improved maize seed for poor smallholder farmers.[59] The program targets almost half of all Malawian farmers. Targeting effectiveness in FISP and other programmes has been widely studied and discussed. Over the life of the programme, changes in area targeting have resulted in more equitable distribution of input vouchers per household, but there have been limited changes in targeting criteria and processes at beneficiary level. Broad beneficiary targeting criteria have allowed wide variations in their application at community level, resulting in biases against receipt of subsidized inputs by poorer people. Widespread and increasing redistribution and 'sharing' of coupons has reduced this bias but increased the likelihood of poorer recipients receiving fewer coupons than less-poor recipients. There have also in some years been gender biases against receipt

[56] ibid.

[57] (Dorward et al. 2008).

[58] Rodney Lunduka at al., 'What Are the Farm-Level Impacts of Malawi's Farm Input Support Program? A Critical Review' (2013) 44(6) Agricultural Economics 563.

[59] Channing Arndt at al., 'The Economywide Impacts and Risks of Malawi's Farm Input Subsidy Program' (Invited paper presented at the 4th International Conference of the African Association of Agricultural Economists, Hammamet, Tunisia. September 2013).

of coupons and access to subsidized fertilizers by female headed households.[60]

On the one hand, an increase in food production is likely to entail a higher demand for water. This decreases water availability indirectly as well as increase health risks and waterborne diseases.[61] On the other hand, given the definition of water security by UN-Water, which emphasizes "acceptable quality water" as a dimension of water security, fertilizer subsidies may directly influence water security.[62] Mineral and chemical fertilizer can be washed away by rain into rivers and lakes and cause eutrophication, which drastically increases algae. Moreover, extensive use of fertilizer can pollute ground and drinking water.[63] Therefore, FISP may have direct and indirect impacts on water security. A direct relationship between energy security and fertilizer exists as the production of ammonia and nitrogen fertilizer requires energy in the form of natural gas. Since Malawi is a net importer of fertilizer, the production of nitrogen does not directly affect energy security in Malawi; however, analysing the potential effects of FISP on energy security at the national level, one can find indirect linkages through higher agricultural output, potentially leading to economic growth and higher energy demand.

4.2 Water Security Policies

Despite its significant water resources, Malawi often experiences droughts with periods of unreliable and poorly distributed rainfall. This has severely affected crop production which often results in families running out of food by November each year. The vulnerable areas tend to be those with average rainfall amounts of less than 1000 mm.[64] In these areas, many of which are located in the South of the country, the variability of the rainfall is higher with actual useful amounts available to the crops being masked by the average figures.[65]

The Ministry of Agriculture and Water Development formulated the National Water Policy (2004) to strengthen and harmonize issues of water resources management and utilization to guide the country in the sustainable use of water. Among its strategies, the policy ensures that the relevant institutions are provided with the relevant information on floods and droughts; and formulation of mitigation measures to reduce the impact of climate change and variability as a means for disaster preparedness and management; but also promoting coordination with other institutions on disaster management. The Water Works Act (1995) and the Water Resources Act (1999) introduced the commercialization and decentralization of urban

[60] Nazaire Houssou and Manfred Zeller, 'To Target or Not to Target? The Costs, Benefits, and Impacts of Indicator Based Targeting' (2011) 36 (5) Food Policy 627 (Dorward et al. 2008).
[61] (UN Water 2013).
[62] Ibid.
[63] Edwin D. Ongley, 'Control of Water Pollution from Agriculture' (Irrigation and Drainage Paper 55. Rome: Food and Agriculture Organization of the United Nations. 1996).
[64] (World Bank, 2010).
[65] ibid.

and peri-urban water supply to parastatal bodies established under its provisions. The act made provisions for the control, conservation, apportionment and use of water resources of Malawi.[66]

With the acceleration of population growth and repeated droughts over the past decades, Malawi is expanding its support for irrigation.[67] In Malawi a total area of 104,000 hectares is irrigated.[68] Since 1994 the irrigated area has increased more than four times.[69] In several areas of Malawi, the irrigation boom is accompanied by the transfer of irrigation management from the government to farmers. Stakeholder participation in irrigation management is expected to encourage sustainable operations by inducing a sense of ownership and responsibility among farmers. Ideally, farmers would plan, build, maintain, and manage their community's irrigation scheme. This transfer of ownership and management from the government to farming communities, called Irrigation Management Transfer (IMT), is rife with challenges and has not yet been entirely successful.[70]

In 2010, Malawi began promoting the Green Belt Initiative (GBI), which is a large-scale irrigation policy for smallholders and commercial farmers to use Malawi's water resources, predominantly Lake Malawi. The Malawian government has offered investors agricultural land near the country's three biggest lakes and perennial rivers to install irrigated agriculture on 1 million hectares by relocating villages.[71] The initiative has been aimed at higher agricultural output of food and cash crops with the goals of increasing macro- and microlevel food security and decreasing poverty. Through subsequent increases in agricultural and nonagricultural growth, it has been found that greater diversification in the agricultural sector and the rest of the economy results in reductions in poverty as well as caloric and nutritional deficiencies. This implies that the GBI has a large potential to increase food security at the macro- and microlevels.

The initiative directly improves water security by increasing water access. Most irrigation schemes are located near Lake Malawi, which could decrease the lake's water levels and water flowing out of rivers, making it difficult to maintain sufficient water levels to produce hydro energy.

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66 (World Bank, 2011).

67 Bryson G. Nkhoma and Wapulumuka O. Mulwafu, 'The Experience of Irrigation Management Transfer in Two Irrigation Schemes in Malawi, 1960s-2002' (2004) 29 Journal of Physics and Chemistry of the Earth 1327.

68 Malawi, MoAIWD (Ministry of Agriculture, Irrigation and Water Development). *National Irrigation Master Plan and Investment Framework*, 2015 Lilongwe, Malawi, mediamanager/documents/Publications/Climate/sei-pb-2013-malawi-energy-access.pdf.

69 P. W. R. Kaluwa at al., 'The Country Situation Report on Water Resources in Malawi. Lilongwe UNDP/SADC Water Initiative.' In W. O. Mulwafu, and B. G. Nkhoma, 'The Use and Management of Water in the Likangala Irrigation Scheme Complex in Southern Malawi,' (2002) 27 Physics and Chemistry of the Earth 839.

70 Nkhoma and Mulwafu (n 67).

71 B Chinsinga and M Chasukwa, 'The Green Belt Initiative and Land Grabs in Malawi' (Future Agricultures Consortium, Policy Brief 55. Brighton, UK November 2012) <http://www.future-agricultures.org/> accessed 5 March 2020.

4.3 Energy Security Policies

The Government of Malawi has developed a number of strategies in the energy sector, including power sector reform, rural electrification, biomass energy and renewable energy.[72] The National Energy Policy (NEP) was approved in 2003 under the remit of Department of Energy Affairs (DoEA); as part of the NEP, a Renewable Energy Framework was launched, to bring more coherence to renewable energy developments.[73] The Power Sector Reform Strategy (PSRS) approved by the Government of Malawi in 2003, provided for the unbundling of Electricity Supply Corporation of Malawi (ESCOM) and private sector participation via long-term concessions in transmission and distribution and entry of Independent Power Producers (IPPs) for new generation capacity. Consistent with these strategies, a set of legislation was approved by the Parliament in 2004, including the Energy Regulation Act, an Electricity Act, a Liquid Fuels and Gas Act, and a Rural Electrification Act.

As part of the reform process, the Government announced that it intends to revise the electricity market structure and the role of ESCOM in the market (particularly the question of multiple licenses held by ESCOM) by revising the Electricity Laws. To this end, the Government will put in place two enabling policy instruments: (i) a Feed-in-Tariff policy, to cover small hydro, biomass and wind resources and (ii) a Standard Power Purchase Agreement framework, to provide clear guidelines on the scope, duration and operational conditions of an IPP contract. A review of the Malawi FIT policy revealed that there were fundamental challenges with the policy which made it rather difficult to attract independent power producers (IPP) thereby frustrating the policy initiative. The most notable challenge with the policy included its lack of stakeholders' participation during policy development. MERA was alleged to have hired a policy consultant who prepared the policy by copying and pasting the Kenyan FIT policy of 2010 without, making relevant modifications to suit the Malawi socio-economic condition. Other challenges with the policy include: Lack of technical expertise, Policy funding, Low end-user tariff being charged by ESCOM utility, Public willingness to pay, Political interference, Grid capacity and Low tariff.[74]

As part of the operationalization of the 2004 energy sector legislation, the Malawi Energy Regulatory Authority (MERA) was formed and the predecessor energy sector regulatory bodies, the National Electricity Council and the Petroleum Control Commission, were dissolved. MERA's role includes inter alia (i) reviewing tariff applications from ESCOM and

[72] (UNDP 2013).

[73] International Energy Agency, 'Tracking Clean Energy Progress 2013: IEA Input to the Clean Energy Ministerial' (International Energy Agency Paris. 2013).

[74] Isaac Chitedze, 'Analysing Feed-in Tariff Policy to Accelerate Renewable Energy Deployment and Electricity Access in Malawi' (Master Dissertation Submitted in partial fulfilment of the requirements for the Master degree in Energy Policy at Pan-African University Institute for Water and Energy Sciences, 2018).

recommending tariff changes to GoM; (ii) granting licenses for generation and distribution operators; and (iii) arbitrating commercial disputes that arise under the 2004 energy legislation.[75]

The government recognizes that the power sector is a key constraint to Malawi's economic growth. The objective of the MGDS was to reduce the number and duration of blackouts, increase access to reliable and affordable electricity in rural areas and other targeted areas, and improve coordination between the needs for energy for households and those of other high growth sectors such as tourism and mining.[76]

Malawi is heavily reliant on biomass for its cooking energy requirements, especially firewood and charcoal, which account for 95% of national energy requirements for cooking.[77] The growing demand for charcoal and wood fuel has been a primary factor in the widespread exhaustion of woodlots across Malawi and is thus an increasingly critical development issue in Malawi.[78] The impacts are multi-sectoral: deforestation is resulting in soil fertility degradation, erosion and river siltation, which in turn undermine subsistence livelihoods, increase flood risks and damage hydro-power infrastructure (World Bank, 2011).[79]

The second MGDS II for the period 2011- 2016 were announced in 2011. In an attempt to minimize the use of biomass fuels the government undertook a number of initiatives: the Program for Biomass Energy Conservation (ProBEC) which promoted the use of clay stoves to save fuel; the Promotion of Alternative Energy Sources Project (PAESP) in 2007 to promote non-traditional fuels for cooking and heating to reduce environmental degradation; and a National Sustainable and Renewable Energy Programme (NSREP) which promoted renewable energy technologies in Malawi.[80] The Malawi Rural Electrification Project (MAREP) has also been established with the primary aims of reducing the large unsustainable wood consumption and improving the dependability of imported oil and coal. The Rural Electrification Act of 2004 is the Malawian Act that provides for the promotion, funding, management and regulation of rural electrification in Malawi. It came into force in March 2004.[81]

5. ANALYSIS OF THE CURRENT W.E.F. NEXUS STRATEGIES IN MALAWI

In line with the UN-SDGs, the following long term (beyond 2020) measures have been proposed (among others) by the Government of Malawi

75 (ESCOM 2013).
76 (SEI 2011).
77 (World Bank, 2011).
78 ibid.
79 ibid.
80 ibid.
81 (Pemba 2013).

to address issues of water, energy and food insecurities holistically and in an integrated manner:[82]

1) Increasing agricultural productivity, thereby reducing pressure on forest resources and increasing energy access and associated economic development goals;
2) Ensure availability and sustainable management of water and sanitation for all;
3) Promoting climate smart agriculture;
4) Promoting soil and water conservation technologies;
5) Use of improved cook stoves and fuel-switching in the household energy sector. Also, high dependence on traditional biomass, hydropower and rain-fed agriculture increases vulnerability to climate change in Malawi
5) Improving access to water and the production of hydro energy
6) Establishing synergies between expanded biofuels production and reduction in traditional biomass use to promoting low-carbon pathways while also improving energy access and stimulating agricultural and rural development.

In addition, the Government of Malawi has welcomed the iSDG – a simulation model for the effective implementation of the UN-SDGs. The model demonstrates clear sectoral interlinkages and provides a platform for trade-offs and synergies in implementation of activities in Government Ministries, Departments and Agencies (MDAs). It is also an instrument for policy reviews and a framework or tool which could also facilitate effective alignment and coordination of donor support and interventions. To translate good simulation results to reality, it is important to ensure that an effective framework for operationalization exists.

Although existing policies have been able to increase food production, this has come with huge environmental, social, and economic costs and threatens the long-term sustainability of agriculture and food security as well as achieving the UN-SDGs in Malawi. For example, the Farm Input Subsidy Programme (FISP) in Malawi which was popular for its distribution of inputs (including fertilisers) to resource poor farmers,[83] was criticized for its adverse impact on water which could cause eutrophication.[84] The WEF nexus may have been inferred in the long-term goals of Malawi, but up till now, the strategies to achieve water, energy and food security are still from the platforms of 'silos' as the interdependencies are not given due attention. For instance, it is clear that water and energy have traditionally been interlinked in Malawi through hydropower plants and large multipurpose

[82] Government of Malawi (n 68).

[83] A typical FISP beneficiary package comprised four vouchers. Two were used to purchase fertiliser (basal and top dressing) and the other two were used to purchase seed (maize and legume).

[84] Thea Nielsen et al., The Food-Energy-Water Security Nexus: Definitions, Policies, and Methods in an Application to Malawi and Mozambique (IFPRI Discussion Paper 01480 November 2015) < http://ebrary.ifpri.org/utils/getfile/collection/p15738coll2/id/129808/filename/130019.pdf> accessed 4 August 2021.

dams. However, new interactions have emerged between water, energy and agriculture sectors that are yet to be properly understood and explored.[85] Crop production now increasingly relies on energy consuming groundwater pumps to meet irrigation needs; energy use in pumping and farm operations accounts for a significant source of energy consumption.[86] This link between energy, irrigation water and agriculture needs to be investigated with improved data collection and policy action. For systems that are expected to function for decades to come, the implications of water and of energy must be evaluated if future water supplies get affected due to climate change or face disruptions in flow across national boundaries. Managing each resource separately can lead to decisions that seemingly improve supply in one sector, but in reality, create problems in others. If the linkages are incorporated in policy evaluation, then unintended consequences may be avoided while multiple problems may simultaneously get addressed.[87]

The existing policies and regulatory frameworks were developed without considering the cross-sectoral consequences and advancement as agencies worked in isolation. The current resource utilization and management style is unsustainable because of the siloed approach used in the different sectors. [88] The lack of coordination and poor inter-sectoral collaborations in Malawi contributes to the unbalanced resource management history of the country. For example, the introduction of the cook-stove in Malawi which uses biomass energy source more efficiently and emits less greenhouse gas are not considered in the water and energy policies as each sector is ignorant of the advancement and challenges of other sectors.[89] The seeming disconnects between the water, energy and food sectors has resulted in the cross-sectoral externalities being ignored and a failure to take into account social, economic and environmental costs. However, strong engagement among the water-energy-food sectors can improve policy and consequently livelihood.

In light of the foregoing, a policy framework will be proposed for the effective operationalizing of the above long term (WEF) goals in Malawi, projecting that the nexus model will be the most optimized model not only for achieving the goals, but also, can set forth the journey for UN-SDGs.

The framework below represents the relationship between SDG Malawi Vision 2020 and the WEF Framework.

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85 (AGWA, 2015).

86 FEWS NET, 'Malawi Food Security Outlook Update' (2017) <https://reliefweb.int/sites/reliefweb.int/files/resources/MW_FSOU_2017_12_final.pdf> accessed 4 August 2021.

87 A Grobicki, 'Water, Food, Energy, Climate: Strengthening the Weak Links in the Nexus' in Felix Dodds & Jamie Bartram (eds.), *The Water, Food, Energy and Climate Nexus: Challenges and an Agenda for Action*. (Routledge 2016)126.

88 Tafadzwanashe Mabhaudhi, 'The Water–Energy–Food Nexus as a Tool to Transform Rural Livelihoods and Well-Being in Southern Africa' (2019) Vol.16(16) International Journal of Environmental Research and Public Health, 1-20 doi:10.3390/ijerph16162970.

89 IFPRI, 'The food-energy-water security nexus in Malawi' (26 October 2016) https://www.youtube.com/watch?v=CGVMWHXBoTY accessed 6 August 2021.

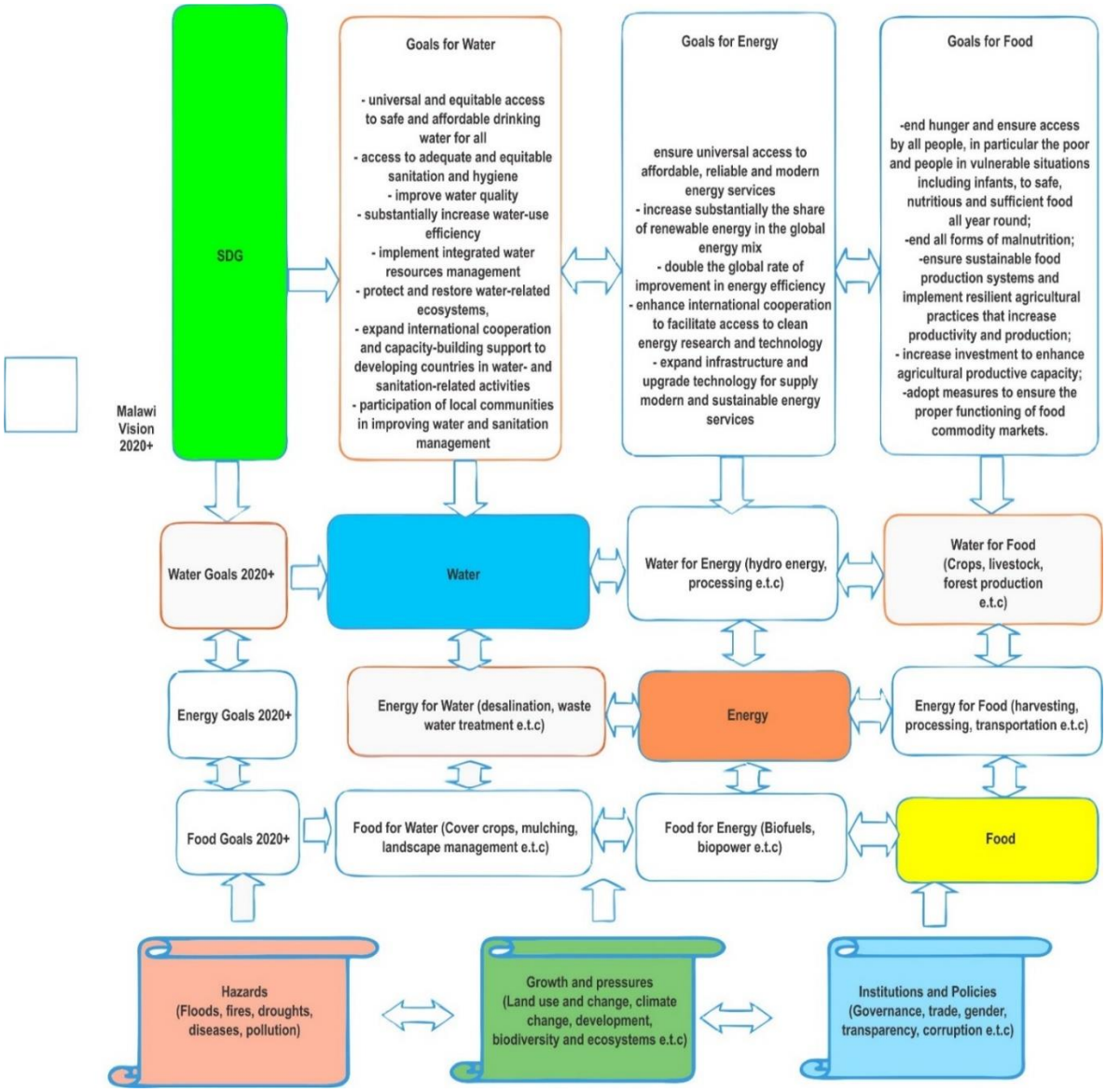

Figure 4: SDG-Malawi Vision 2020+ /WEF Framework

Enabling conditions for horizontal and vertical policy coherence of the WEF Nexus initiatives post 2020 in Malawi includes institutional capacity building, political will, change agents and awareness-raising. This can be realized if the nexus is addressed coherently across all scales through multi-level governance.

The framework above has been analysed in the context of "Risk Analysis", reckoned with. Thus, unless risk is not fully comprehended, the WEF linkages would poorly be understood hence policy making will miss

on the "wholeness". The risk analysis model has been conceptualized and popularized by IRENA.[90]

6. IMPLEMENTING THE NEXUS APPROACH: RECOMMENDATIONS

A review of selected published articles on the WEF nexus clearly indicates that opportunities exist to implement the nexus approach at different scales, that is, at national, regional, and local levels, provided there is recognition of the need, understanding of the extent of interconnections and their consequences, and willingness to reform sectoral policies and strategies toward more integrated and cost-effective planning, decision-making, implementation, monitoring, and evaluation. A nexus approach facilitates better understanding of the complex and dynamic interrelationships. Effective cross-sectoral consultation mechanisms are therefore needed to ensure the development of concerted efforts to address this WEF security issue, and to make sure that decisions are taken as part of an integrated, long-term, and multisectoral strategy. The following (adopted) areas of interventions are therefore recommended in order to promote the adoption of a nexus approach in planning and decision making in Malawi:

Involvement of stakeholders to build awareness of and capacity for the interconnected nature of the elements of the WEF nexus, share ways to minimize trade-offs, explore synergies, and suggest actions for changing behaviours with regard to the nexus and other actors whose well-being relies on services and products associated with elements of the nexus. This includes community-level empowerment using core resources to focus on more sustainable consumption.[91]

Improvement of policy development, coordination, and harmonization to account for trade-offs and build on the increased interconnectedness of WEF. Part of this process is promoting, identifying, and eliminating contradictory policies.[92] Despite the strong linkages among Water, Energy and Food, a continuity of approach in the developmental sector (Academia & Practitioners) over the decades, has always been in the "silos". To maximize WEF in its output from resource perspective, a mechanism of awareness on part of policy makers is very important. The re-evaluation of agricultural investments after a food crisis is reactionary, for the most part, but it is an impetus for thinking in the interconnectivity of resources and the complexity

[90] (International Renewable Energy Agency, 2015).

[91] Mitu Gulati et al., 'The Water-Energy-Food Security Nexus: Challenges and Opportunities for Food Security in South Africa' (2013) 1 Aquatic Procedia 150 <https://doi.org/10.1016/j.aqpro.2013.07.013> accessed 14 May 2019

[92] MituGulati et al., 'The Water-Energy-Food Security Nexus: Challenges and Opportunities for Food Security in South Africa' (2013) 1 Aquatic Procedia 150 <https://doi.org/10.1016/j.aqpro.2013.07.013> accessed 14 May, 2019; L Nhamo et al., 'The water-energy-food nexus: Climate risks and opportunities in southern Africa' (2018) 10 Water 18.

of linkages of food with energy, land and water. The SDGs will be the first litmus test for the nexus model and the resources linkages in Malawi.[93]

Governance, integrated and multi-stakeholder resource planning to promote cross-sectoral and cross-departmental approaches to planning and working with stakeholders at different levels to improve public-sector-led governance, planning, and information flows.[94]

Promoting innovation: to identify technological choices and investments that explore WEF synergies and could be implemented to achieve desired changes on the ground. As in many developing countries, policies in Malawi tilt towards '*Supply*', hardly considering conservation. Conservation can be the key to green economy in future and the resource sustainability can be assured, which is a national and global goal. With the advent of renewable technologies in the energy sector in Malawi as well as the technological adaptation mechanisms in the agriculture sector, such conservation policies can be useful tools in achieving the resources sustainability.[95]

Monitoring, evaluation, and feedback mechanism to appraise functioning of individual systems as per agreed policies and strategies, identify operational changes needed, and provide feedback to steps 2, 3, and 4.

Influencing policies on trade, investment in environment/climate by focusing on improving ecosystem management to increase resource productivity, thus contributing to poverty alleviation and green growth.

Trade, regional integration and foreign policy should be utilized to manage nexus trade-offs more effectively and contribute further to resilience at both state and global levels. This trade in energy will have long term effects on food and water.[96]

Curbing subsidies in all the resource sectors (Water, Energy and Food) will pave the way for their accessibility. Apart from the fact the subsidies are directly proportionate to the resource it often leads to unintended consequences for other sectors. Thus, a nexus approach is to review, identify and scrutinize the trade-offs in the context of "*At the cost of what?"*[97]

The above policies are imperative. But arguably, the first recommendation contains two key components that would determine the effective implementation of the Malawi WEF nexus: (a) the inclusivity of stakeholders and (b) capacity development.

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93 M Mapak and L Mbewe, *Renewables and Energy for Rural Development in Sub-Saharan Africa.* (Zed Books 2013).

94 T Mabhaudhi, 'Southern Africa's water–energy nexus: Towards regional integration and development' (2016) 8 Water 235.

95 (Chauvin, Mulangu & Proto, 2012); A. Grobicki (n 78).

96 J Faurès et al., 'Reinventing irrigation', in David Molden (ed.), *Water for food, water for life: A comprehensive assessment of water management in agriculture* (London, Earthscan 2007) 315; S. Naik, 'Water Crisis in Africa: Myth or Reality' (2017) 33 (2) International Journal of Water Resources Development 326; P. Rios, et al., 'Explaining Water Pricing Through a Water Security Lens' (2018) 10 Water 1173; (Dodds & Bartram, 2016).

97 S Naik, 'Water Crisis in Africa: Myth or Reality' (2017) 33 (2) International Journal of Water Resources Development 326; P. Rios, et al., 'Explaining Water Pricing Through a Water Security Lens' (2018) 10 Water 1173; (Friere, Lau and Leipziger, 2015).

An effective harmonization of WEF policies and institutions will be a function of deliberate stakeholder mapping and capacity development. Thus, the operationalizing of the Malawi WEF/SDG framework, represented in Figure 4, would depend largely on the strength of the stakeholder mapping and capacity development.

6.1 Inclusivity of Stakeholders

The discussion of the nexus can be reframed for more effective identification and deployment of solutions that address the associated challenges. Business as usual is no longer acceptable: it is necessary to engage new and current stakeholders in novel ways. The nexus challenge needs to be represented as an opportunity for innovation that will drive economic development, business expansion, ecosystem health and social well-being.

This is an opportunity to move stakeholders toward a 'can-do' mindset that provides win-win benefits for societies, economies and the environment. A shift in thinking is proposed to accomplish several goals, including:

- Broad stakeholder engagement in developing innovative solutions to address energy–water–food nexus challenges.
- Defining 'nexus innovation' in terms of technology, partnerships, funding/financing, and of business, consumption/production models.
- Framing a vision and strategy to effectively address the nexus challenges.
- Leveraging new governance modalities and exponential technologies to accelerate innovations towards achieving energy–water–food security for all.

Quantitative tools and models can provide a clear understanding of the interconnectedness of the nexus by identifying the trade-offs and the potential synergies involved. These tools and models also serve to identify the challenges and interconnectedness across multiple actors and sectors, for example, in assessing policy coherence, testing the potential of various policy mechanisms, identifying current and future challenges, and offering solutions pertaining to resources planning and implementing impacts of specific technologies and infrastructure at large scale.[98] The modelling framework provides the opportunity to engage key stakeholders, thereby offering a cross-sectoral understanding of associated challenges and opportunities. Stakeholder participation in the modelling processes contributes to local ownership of these tools. Similarly, decision makers can also be involved, because their interest is more focused on the outcomes, rather than applications, of the tools. Therefore, decision makers can play a

[98] R Mohtar and B Dahar, 'Water-Energy-Food Nexus Framework for Facilitating Multi-Stakeholder Dialogue' (2016) 41 (5) Water International 655 <https://doi.org/10.1080/02508060.2016.1149759> accessed 14 May 2019.

prominent role in co-creating model scenarios and interpreting model results.

The joint development and learning which derives from this process, contributes to strengthening dialogue and improving understanding of the issues faced by the various actors. Beyond sector-specific goals, it moves the focus towards the interdependence of resources and production of goods and services in the other sectors. This facilitates the dialogue and helps create a shared agenda, enabling the identification of options for its realization.

The challenges in modelling WEF nexus hotspots are not limited to technical ones. As discussed in the previous section, other challenges may include institutional fragmentation; disincentives within the regulatory, legal and policy frameworks that fail to incentivize cross-sectoral collaboration in planning and investment design; short-term planning horizons, driven, in many cases, by political cycles; lack of the data and short time frames for providing results; and lack of incentives that promote collaboration and identify synergies for improved planning and decision making. Other related challenges may include varying power relations between the different actor groups; the location of different actor groups at various levels (local to national); identifying a host institution for the stakeholder interaction process; and the time needed to follow implementation and policy processes in relation to a research project (which may only last a year or two).

Failing to involve stakeholders in the modelling process increases the likelihood that outputs will be neither relevant to nor demanded by the actors they are meant to benefit. Current experience with nexus modelling frameworks results in valuable exercises that begin to identify and illustrate not only the trade-offs that must be made but also the synergies that can be achieved, particularly in budget-constrained environments. These exercises have demonstrated the value of modelling to identify and quantify the trade-offs and synergies of collaboration. These are reflected in better planning frameworks and, more importantly, in understanding the financial gains from joint investment planning and design. Models can provide clear policy guidance to enable maximization of financial, economic, social and environmental benefits across sectors.

6.2 Capacity Development

This section seeks to emphasize the fact that capacity development and building awareness about the interconnected nature of all elements in the nexus, trade-offs in resource use, improved policy development, coordination, and overall governance of the nexus are some of the important elements needed to operationalize the nexus and gain benefit on a sustainable basis at all levels.

Capacity development entails the sustainable creation, utilization and retention of that capacity, in order to reduce poverty, enhance self-reliance, and improve people's lives. Capacity development builds on and harnesses

rather that replaces indigenous capacity. It is about promoting learning, boosting empowerment, building social capital, creating enabling environments, integrating cultures, and orienting personal and societal behaviour".[99]

Capacity development is committed to sustainable development for a long- rather than short-term perspective of continual learning and acquiring of skills and resources through individuals' participation and dedication toward enhancement of organizational and institutional strength in addressing development issues. This clearly indicates that capacity development involves something more than the strengthening of individual skills and abilities. Trained individuals need an appropriate environment, and a proper mix of opportunities and incentives to use their acquired knowledge. The implication is that the capacity development initiatives should be addressed in an integrated manner at three levels: the individual, the institution, and the enabling environment.

Formal education and training provide the basic foundation for knowledge building and capacity development. At the individual level, capacity development refers to the acquisition of knowledge, understanding, skills, and attitudes through formal education or other forms of learning. Although some of the necessary skills can typically be acquired on the job or through learning by doing, one needs to rely more on formal education and training for acquisition of knowledge, understanding, and attitudes. Training can be accomplished through apprenticeships and mentoring, seminars, workshops, classes, or through self-study. Ability to work in a team, capability to approach a complex challenge, and ambition and the drive to keep learning are some of the required skills and attributes the individuals must develop.

The institutional capacity at different levels of the organizations and the enabling environment should be adequate to adapt modern approaches in science, technology, and management, which are essential to deal with the complex challenges in the development sector. As individuals enter into professions, they nurture their knowledge and acquired skills in a collective manner in addressing the management issues within the institutional and organizational framework. Capacity building at the organizational level is therefore needed, focusing on infrastructure and institution building, the availability of resources, and the development of organizational processes that would lead to an efficient and sustainable use of resources. At the systems scale, capacity development seeks to enhance the consistency of sector policies and promote better coordination between organizations of different sectors with the objective of a common goal of sustainable development.

[99] Organization for Economic Cooperation and Development, 'Perspectives Note: The Enabling Environment for Capacity Development' January 2011; United Nations Development Programme (UNDP). *Capacity Development: A UNDP Primer*, (UNDP, New York 2009).

Organizations with the right capacity and procedures still need an enabling environment to implement legal and regulatory frameworks for development and management. Finally, knowledge and understanding at the society level is imperative through different means of awareness rising on the broader perspective of sustainable development.

Developing educational programs across disciplines is a challenging task. Providing a broader understanding across disciplines is desirable, and will produce graduates who understand issues, but not experts to carry out research and implement programs. To strike a balance between a broad overview of education and the specialization required, a nexus academic programme should comprise three components that provide the following: (i) a broad holistic viewpoint, through overview courses; (ii) a deep understanding of a particular field through specialized courses; and (iii) a set of courses to provide the skills needed to implement research, through competency courses. This should be followed by a field-scale research on specific problems. A new mode of transdisciplinary, problem-and-solution-oriented education and research is to be adopted on top of the traditional academic research that seeks the involvement of a wider set of institutions and types of researchers to work together on specific problems within specific contexts. Research should not be exclusively based in universities but should be conducted on site together with the implementing agencies, user communities, and professional bodies. The objective of this arrangement is to bring in the local knowledge and perception into the process and the whole exercise pursued in an interactive manner with active participation of all stakeholders. The field-scale research, in this sense, can be envisioned to seek solutions based on different models that link environment, society, and economy. A set of feasible solutions for a given problem is obtained through environmental analyses. A subset of those solutions is then identified which also satisfies economic constraints, and finally solutions that meet social acceptance are selected for implementation. The analysis of each structured case will enable policymakers, scientists, and community representatives to negotiate constraints and benefits while making a science-based selection.

7. CONCLUSION

Malawi is facing growing challenges in meeting the growing demand for food, water, and energy in the face of competing demand for resources and increasing environmental pressure. To increase cereal production, it has introduced many policy initiatives including providing incentives through subsiding water and energy and guaranteeing prices. While such incentives have helped increase cereal production, they have also increased the demand for water and energy, led to degradation of the resource base, and contributed to an increase in water-related disease. Although the food,

water, and energy sectors are inherently interconnected, the connection in terms of policy and implementation is weak.

The paper has proposed an integrated framework that would facilitate synergies and trade - offs while exploring the nexus approach in Malawi. The key elements of the framework are strengthening cross-sectoral coordination, harmonizing public policies, aligning cross-sectoral strategies and incentive structures, strengthening regulation, and facilitation of nexus smart investment and technologies. Critically, the research demonstrates that in addition to proper stakeholder mapping and consultation, capacity development and building awareness about the interconnected nature of all elements in the nexus, trade-offs needed in resource use, improved policy development, coordination, and overall governance of the nexus are some of the important elements needed to operationalize the nexus and gain benefit on a sustainable basis at all levels. Capacity development is committed to sustainable development of a long- rather than short-term perspective of continual learning and acquiring of skills and resources through individuals' participation and dedication toward enhancement of organizational and institutional strength in addressing development issues. Thus, a new mode of transdisciplinary, problem-and-solution-oriented education and research is to be adopted on top of the traditional academic research that seeks the involvement of a wider set of institutions and types of researchers to work together on specific problems within specific contexts.

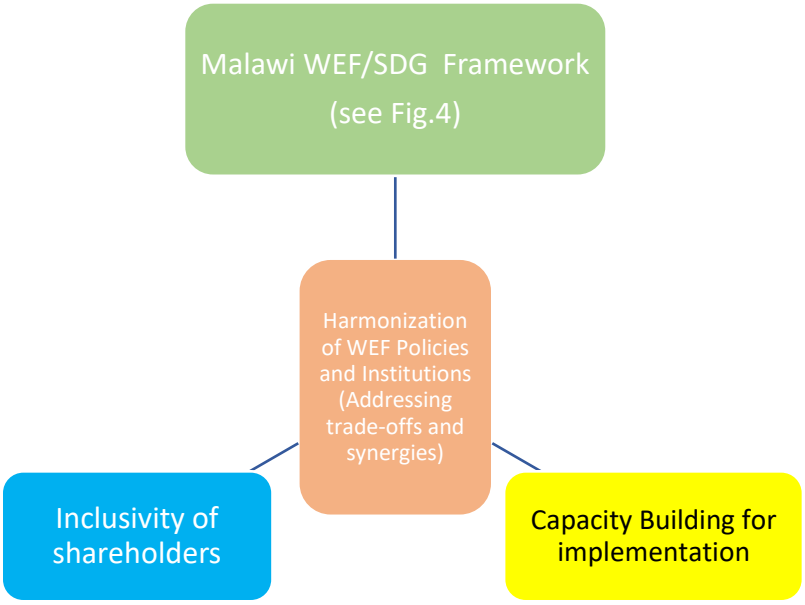

Figure 5: The Influence of Inclusivity and Capacity Development on the Malawi WEF/SDG Framework.

It is strongly recommended that the National Institutions of Higher Learning in Malawi collectively take initiative in developing a structured curriculum for postgraduate degree in sustainability science across

traditional disciplines of science and engineering. This endeavour is highly important as the county is in need of extending specialization in different disciplines. Field-scale research, indicated as an important component of transdisciplinary education and research, is to be conducted in a "shared vision planning and analysis" mode. Such mode shall incorporate tried-and-true planning principles, technical analysis, and public participation into a practical forum for making resource management decisions that will be capable of addressing the identified issues and concerns.

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AUTHORS' DECLARATIONS AND ESSENTIAL ETHICAL COMPLIANCES

Authors' Contributions (in accordance with ICMJE criteria for authorship)

Contribution	Author 1	Author 2
Conceived and designed the research or analysis	Yes	Yes
Collected the data	Yes	Yes
Contributed to data analysis & interpretation	Yes	Yes
Wrote the article/paper	Yes	Yes
Critical revision of the article/paper	Yes	Yes
Editing of the article/paper	Yes	No
Supervision	Yes	No
Project Administration	Yes	No
Funding Acquisition	No	No
Overall Contribution Proportion (%)	60	40

Funding
No funding was available for the research conducted for and writing of this paper.

Research involving human bodies (Helsinki Declaration)
Has this research used human subjects for experimentation? No

Research involving animals (ARRIVE Checklist)
Has this research involved animal subjects for experimentation? No

Research involving Plants
During the research, the authors followed the principles of the Convention on Biological Diversity and the Convention on the Trade in Endangered Species of Wild Fauna and Flora.

Research on Indigenous Peoples and/or Traditional Knowledge
Has this research involved Indigenous Peoples as participants or respondents? No

(Optional) PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)
Have authors complied with PRISMA standards? No

Competing Interests/Conflict of Interest
Authors have no competing financial, professional, or personal interests from other parties or in publishing this manuscript.

RIGHTS AND PERMISSIONS